

# Humans 2.0

Improving the Human Condition

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# What If We Didn't Need Sleep?

It would make the “choose two: {sleep, grades, friends}”  
dilemma so much simpler...

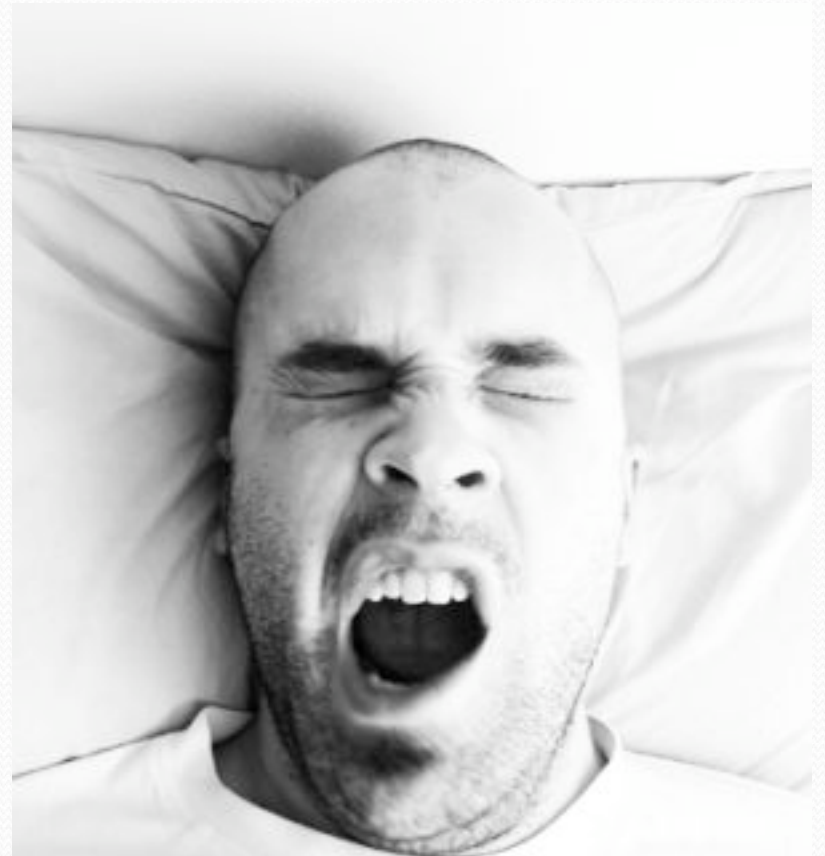
# Importance

- Sleep affects everyone!
- Serious problems/effects of sleep deprivation
  - Decreased mental function (memory, recognition, etc.)
  - Cardiovascular problems, weight gain



# Impact

- Start with specific applications: large “delta” for small population
  - Military, College students, etc.
- Expand to broad applications: smaller “delta” for large population
  - General productivity booster?
- Short- and long-term health risks?



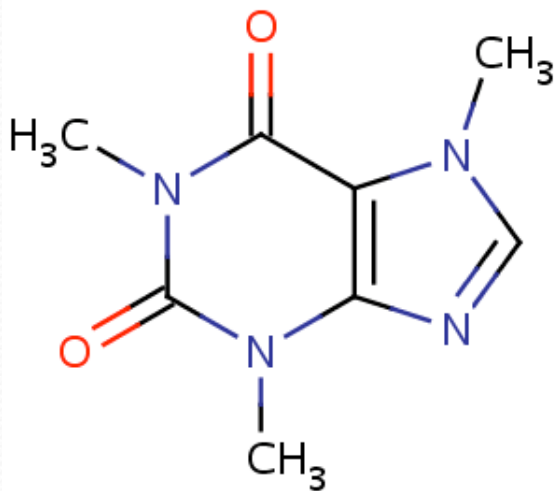
# Knowns/Unknowns

- Much is still unknown about sleep
  - Why do we sleep at all?
  - What are the results of sleeping?
- What we know about sleep
  - 4 Stages: N<sub>1</sub>, N<sub>2</sub>, N<sub>3</sub>, REM
  - Occurs in cycles lasting 90-110 mins.
  - N<sub>3</sub>, REM are “deep sleep” cycles
  - REM only accounts for ~30% of sleep
  - Possible to “isolate” REM sleep?



# Competition

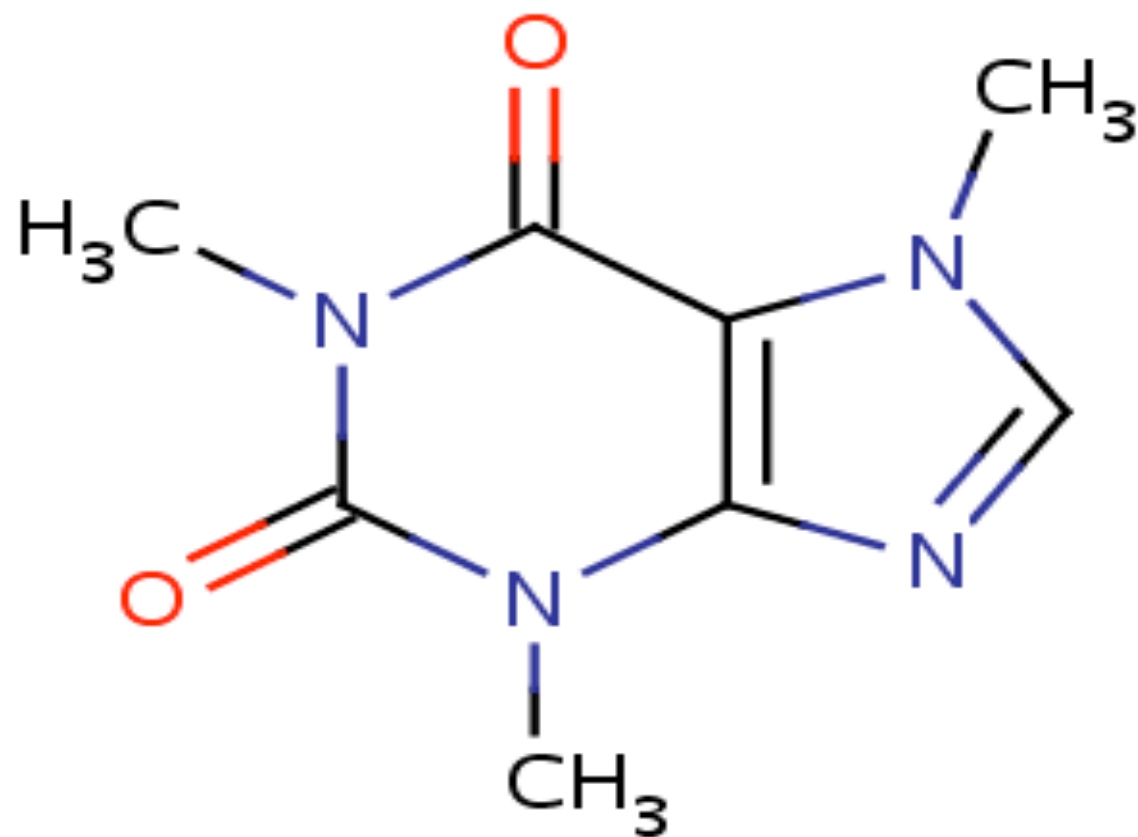
- Many research institutions are investigating the causes/effects of sleep
- Drug stimulants
  - Caffeine!
  - Modafinil



# Our Idea


- “Curing” sleep might be too ambitious, given how little is known about the causes of sleep
- Increase the level of tolerance for caffeine by manipulating the adenosine receptors





# SLEEP

You don't *really* need it, do you?

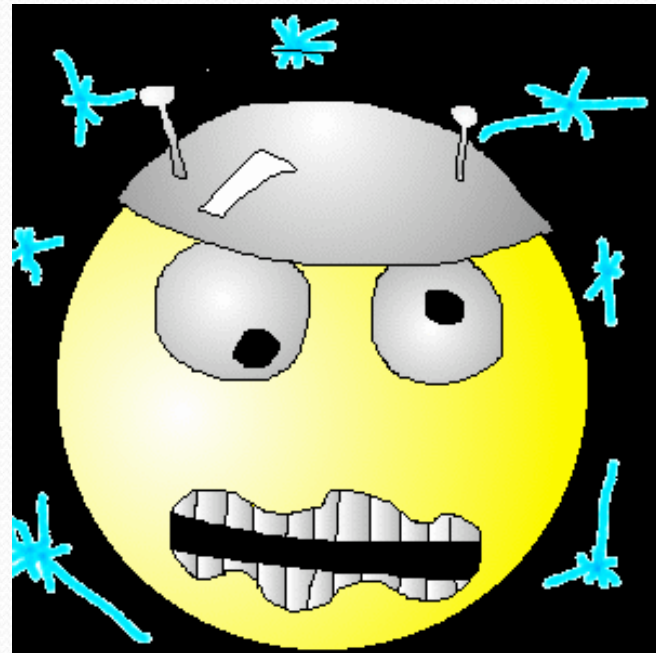
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- Although sleep is not fully understood, the manipulation of neural receptors could play an important role in increasing tolerance to sleep deprivation
  - Another important method for improving the functioning of the brain, and particularly for healing the damaged brain, is through the regeneration of neurons

# Neuron Regeneration!

Brain damage? No problem! 😊

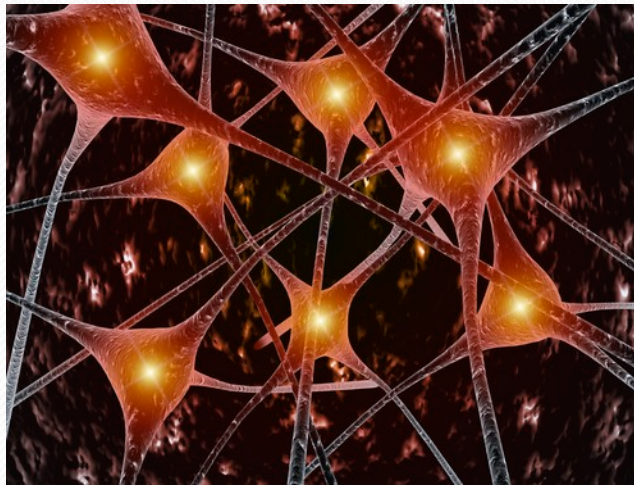
# Importance

- There is no way to repair damaged neurons
- Serious problems!
  - Loss of motor functions
  - Brain disorders
  - Dead neurons



# Impact

- Affects only a limited segment of the population (injury, Alzheimer's, etc.) – but impact would be tremendous.
- Would allow those who suffer from brain damage to have returned physical and mental functioning



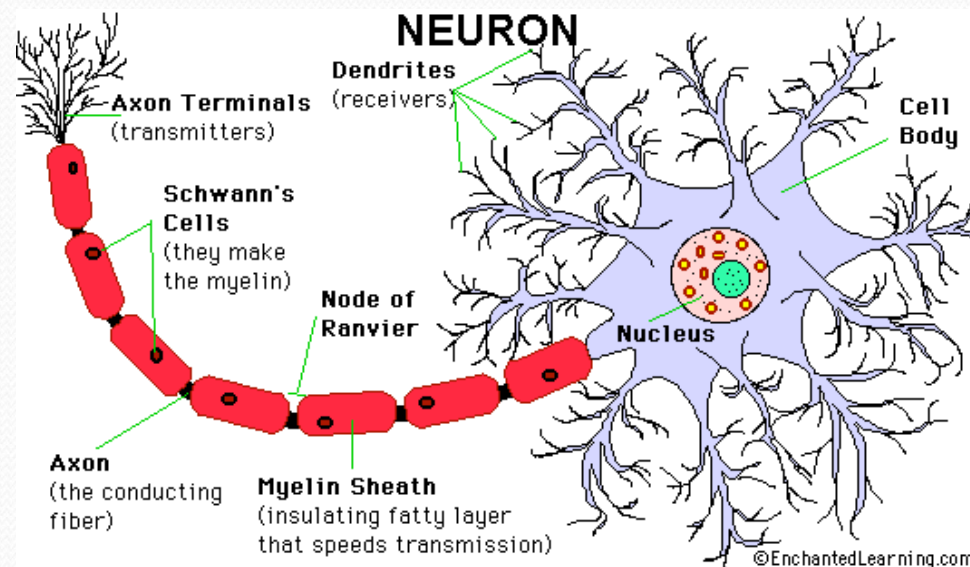


# Competing Technologies

- Use of stem cells to replace damaged neurons
- Stimulation of nerve cells to help regrow neural connections in the brain
- Turning off or blocking pathways that inhibit regrowth of neurons
  - Three inhibitors of axon regrowth known to date are Nogo, myelin-associated glycoprotein (MAG) and myelin-oligodendrocyte glycoprotein (OMgp)

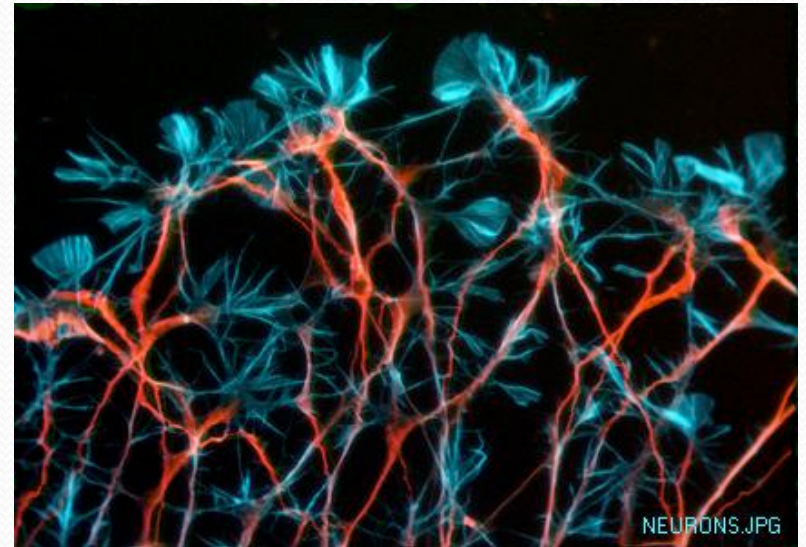
# Knowns

- Basic structure of neurons
- Neural pathways and the use of neurotransmitters to communicate within the brain
- Neurons can be regenerated with the use of stem cells

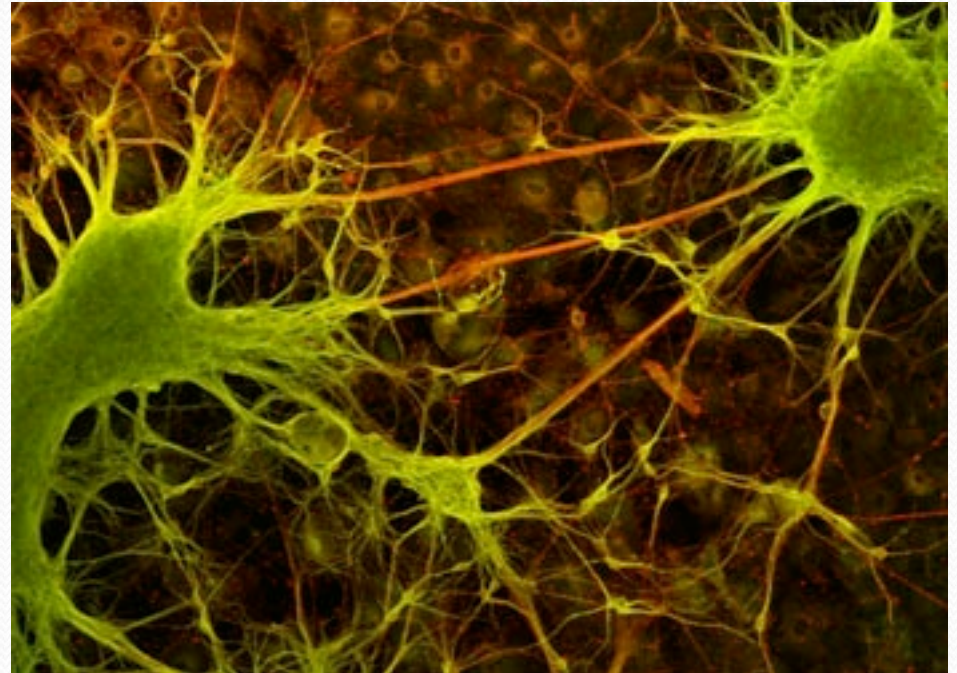


# Unknowns

- Efficient techniques for replacing damaged neurons
- Nature of genes associated with the regeneration of neurons
- Neurons within the adult brain that regrow axial projections have been found, but the genes that encode for this growth and the proteins that they translate are not well known



- Inserting regenerated neurons into the brain or stimulating the regeneration of neurons within the brain could allow for the recovery of mental and physical functioning



- Neuron regeneration could help to cure patients who suffer from neurodegenerative diseases, such as Alzheimer's

# Alzheimer's: A Bioengineering Approach

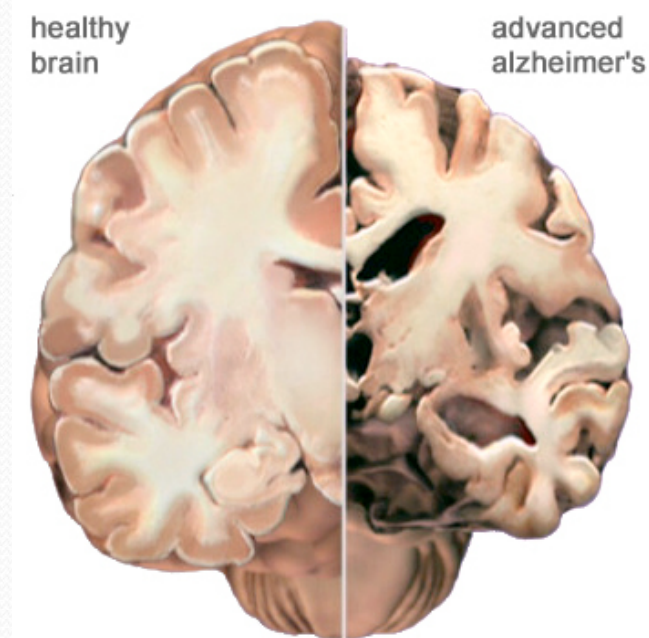


# Importance

- Highly degenerative disease that is ultimately fatal
- Lowers the quality of life and decreases the capacity to function of society of those who suffer from it
- An estimated 26.6 million people 65 years and older had Alzheimer's worldwide in 2006
- Thus Alzheimer's has terrible and irreversible degenerative effects on a large number of people

# Impact

- Memory makes you who you are!
- Will help people with Alzheimer's and other forms of dementia retain their lifelong experiences
- Preserves family unity
- Reduces Human Suffering

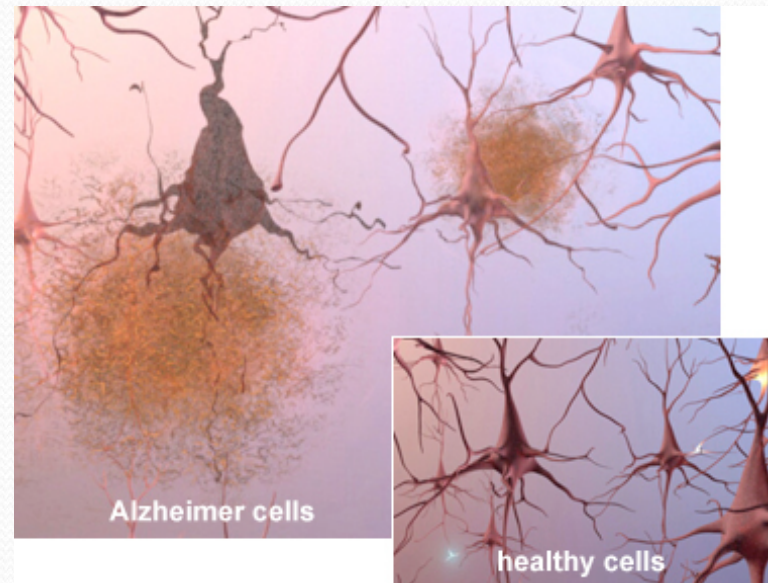


# How to stop the loss?

- Rearrange the fibers to their original position
- KILL the plaques
- We are proposing to monitor them using “bio-markers”

## Issues for Treatment

- Blood-Brain Barrier
- Limited Imaging of the Brain



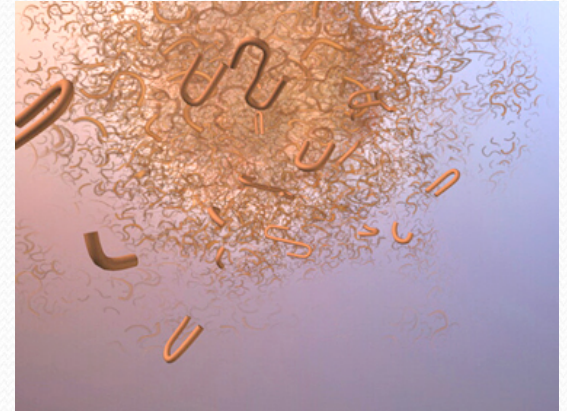


# Knowns

- Senile plaques and neurofibrillary tangles are directly associated with Alzheimer's
- Possible Genetic Component: Mutations on Chromosomes 9 and 19
- The cells ultimately die
- Causes the brain to shrink
- Protein pieces clump together in the brain
- Chemically “sticky” (they bond easily)
- The clumps block signals and ultimately kill the cells!!

# Unknowns

- What causes plaques to form
- What types of neurons are affected
  - Why are certain areas of the brain affected
- Structure of the protein plaques
- Time that it takes the clumps to be “big” enough to block the neuro-signals
- “Twisted” Proteins: What causes them to entangle?





# Competing Technologies

- Many pharmaceutical treatments focus on neurotransmitters NOT on plaques and tangles
- Clinical Trials
- The U.S. Food and Drug Administration has approved four drugs to treat AD. For people with mild or moderate AD, donepezil (Aricept®), rivastigmine (Exelon®), or galantamine (Razadyne®).
- Namenda regulates glutamate which plays a key role in processing information.
- Treatments Researched: Breaking down beta-amyloid plaques, anti-inflammatory drugs



# Summary

- Manipulating receptors on neurons can play a major role in the transfer of information through neural pathways
  - Changing adenosine receptors can help increase tolerance to caffeine
    - Caffeine supplements could be more continuously effective in decreasing the need for sleep
  - Changing neural receptors can also allow for specific drug treatments and chemicals to be transferred to neurons for medicinal purposes
- Regeneration of neurons is a major concern since most neurons are in a state of non-replication
- The regeneration of neurons could allow for the treatment of patients with Alzheimer's and other forms of dementia
- The removal of plaques and the detangling of neurofibers could improve neural functioning and ultimately help to prevent the progression of Alzheimer's

# Resources

- <http://www.pnas.org/content/100/13/7430.full>
- <http://www.alseres.com/science-technology/nerve-repair.asp>
- <http://www.narcis.info/research/RecordID/OND1325851/Language/en/;jsessionid=iohc281m2bl>
- <http://alzheimersdiseaseaid.com/origins-unknown--the-battle-with-alzheimer-s-continues.php>
- <http://www.nia.nih.gov/Alzheimers/AlzheimersInformation/Treatment/http://alzheimers.about.com/od/treatmentofalzheimers/a/treatments.htm>
- <http://web.mit.edu/newsoffice/2008/alzheimers-protein-o821.html><http://www.nanowerk.com/spotlight/spotid=5262.php>